**Objectives**

Upon completion of this activity, you will be able to:

* Identify processes in the carbon cycle and water cycle that are related to each of the causal principles.
* Identify similarities and differences between the water and carbon cycle.

**Causal Principles**

1. Gravitational energy, thermal energy and/or chemical **energy** drive all movement and change of matter on Earth.

2. A system is in **equilibrium** when energy in the system is balanced.

3. Matter moves and changes to return a system to **equilibrium.**

4. **Energy** is needed to break bonds and is released when bonds form.

1. **Temperature** is a measure of the movement of molecules. Higher temperature means molecules are moving faster.
2. When molecules move faster, the **density** of most substances decreases. Water is an anomaly because liquid water is more dense than ice.
3. **Buoyancy** causes materials to rise or fall due to the relative density of materials.
4. **Feedback Loops** can accelerate, decelerate, or dampen change.

**PART 1: Background Notes**

**Part 2: Group Work**

For both of the cycles, identify processes that relate to the causal principles we have referred to throughout the semester in Table A. Multiple correct answers may exist for a single principle.

|  |  |  |
| --- | --- | --- |
| Table A. The role of the causal principles in the water and carbon cycle. | | |
| **Principles** | **Water Cycle** | **Carbon Cycle** |
| 1. Gravitational energy |  |  |
| 1. Chemical energy |  |  |
| 1. Thermal energy |  |  |
| 2. A system is in equilibrium when energy in the system is balanced. |  |  |
| 3. Matter moves and changes to return a system to equilibrium. |  |  |
| 4. Energy is needed to break bonds and released when bonds form. |  |  |
| 5. Temperature is a measure of the movement of molecules. |  |  |
| 6.When molecules move faster the density of most substances decreases. |  |  |
| 7. Buoyancy causes material to rise or fall due to the relative density of materials. |  |  |
| 8. Feedback loops can accelerate, decelerate, or dampen change. |  |  |

Fill out Table B to the best of your abilities. Multiple correct answers may exist for a single box. Try to include your reasoning along with your answer – What evidence do you have to support your answer?

|  |  |  |
| --- | --- | --- |
| Table B. Features of the Water and Carbon Cycles | | |
| **Feature** | **Water Cycle** | **Carbon Cycle** |
| Largest Reservoir |  |  |
| Longest Residence Time |  |  |
| Gravitational Energy is Most Important  *(Choose either water or carbon cycle)* | *Yes No*  *(circle one)* | *Yes No*  *(circle one)* |
| Chemical Energy is Most Important  *(Choose either water or carbon cycle)* | *Yes No*  *(circle one)* | *Yes No*  *(circle one)* |

**Questions**

1. Imagine we rapidly uplift a large chunk of continental lithosphere to make a huge mountain range. This would expose a large volume of rocks, eventually producing small pieces of rock and chemical products, such as bicarbonate, during weathering. These weathering products make their way into streams and eventually oceans.
   1. How would this uplift impact the residence time of CO2 in the atmosphere?
   2. Significantly more CO2 exists in the atmosphere since the industrial revolution and the widespread use of fossil fuels. What has been the impact of this added CO2 on the weathering rate of rocks found in mountains, monuments, and bricks?
2. Describe a situation where the size of a reservoir in the carbon cycle is changed and how this impacts the residence time of CO2 throughout the entire Earth system.
3. Describe a situation where the residence time for a reservoir in the carbon cycle is changed and how this impacts the residence time of CO2 throughout the entire Earth system.

**Part 3: Homework**

If you complete the group work, you may work on the homework **on your own.** This means your answers should be generally unique from other students’ answers. **Submit your homework using ANGEL**.

For each of the following causal principles, provide at least two corresponding examples of movement or change in the carbon cycle.

1. Matter moves and changes to return to equilibrium.
2. Gravitational energy drives movement.
3. Energy is released when bonds form.
4. Positive feedback accelerates change.